SECRET

TECHNICAL PROPOSAL

FOR

SYSTEM 6

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including this title sheet.)

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1. General Description of System 6

a. This proposal describes an airborne electronic reconnaissance system (System 6) which will record data concerning signal activity in the frequency range from 50 mc to 14,000 mc. (See figure 1.) This frequency range will be covered in four bands as follows:

P-Band	50 mc - 300 mc
L-Band	300 mc - 1000 mc
S-Band	1000 mc - 8000 mc
X-Band	8000 mc - 14000 mc

b. Most of the functional units of System 6 were previously developed by this contractor for other systems, while some are commercially available units modified for use in System 6. This system is designed to be carried in the vehicles used to carry "A" and "B" camera equipment.

c. Radio-frequency preamplifiers will be provided between the antennas and detectors of the P-Band and X-Band receiving channels. Although, r-f preamplifiers will not be included immediately in the S-Band and L-Band receiving channels, these channels are designed so that preamplifiers can be included when they become available.

d. System 6 will be wired so that the latest vacuum-tube version of the System 1 information amplifier and power supply may be used immediately, and transistorized versions of these units substituted at a later date.

e. A right-looking, and a left-looking antenna will be used for each receiving channel. The right, and left antenna will be alternately switched into its associated channel. In addition, an alternate P-Band antenna configuration will be supplied for the reason indicated in the following paragraph.

f. The right and left antennas for L-, S- and X-Band reception will be mounted inside of the aircraft so that its aerodynamic characteristics will not be affected. In the case of the P-Band antennas (modified scimitars), one will be mounted on the outside surface of the fuselage back of each wing, and at an angle of 30 degrees with respect to the horizon. These antennas may therefore affect the aerodynamic characteristics of the aircraft by a significant amount. For this reason, an alternate P-Band antenna designed to be mounted on the underside of the aircraft will also be supplied. The mountings for the right and left antenna pair and for the single antenna will be designed so that either antenna configuration may be rapidly installed and removed as required.

g. Figure 2 shows the location of the units of System 6. These units are distributed so that the center of mass of the system will be as close as feasible to the center of gravity of the vehicle. The weight of the interconnecting cables will be kept to a minimum.

h. The S-Band portion will be installed in the nose in the same manner as the units of "System 1" are installed. One recorder will be mounted in the pilot's compartment, and the L-Band and X-Band portions will be mounted on the equipment bay hatch cover. The second recorder, the P-Band preamplifier, the timer, and the two power supplies for the four information amplifiers will be carried in the cheek area. The various antenna switches and filters will be mounted adjacent to their corresponding antennas.

i. For both "A" and "B" configurations, the nose and cheek area installations of System 6 components will be identical. However, because of the difference in the two camera configurations and in the hatches used with them, there will

be differences in the mounting of those units of System 6 which will be placed in the equipment bay. In addition, modifications will be required of the L-Band antennas used with the "B" hatch covers to prevent their interfering with the "B" camera.

j. The two recorders will be interconnected so that the timing track of one will be slaved to the other. The 1-kc clock in the master recorder will be placed on track 1 of both recorders, and the corresponding clock in the slave recorder deactivated internally. The left-right timer will key the 3-kc tones of both recorders to indicate the antenna switching function. The pilot's voice will be transcribed onto the No. 1 track of both recorders. Finally, event markers and tracker dip signals may optionally be impressed upon both recorders.

k. The signals from the S-, and X-Band information amplifiers will be sent to the recorder located in the pilot's compartment. These signals will also be made available to the AIC/10 intercommunication amplifier in the vehicle via filter circuitry. The output of the X-Band information amplifier will be sent through a filter-amplifier located in the B unit which passes frequencies above 1900 cps. The output of the S-Band information amplifier will be sent through a filter-amplifier located in the nose area which uses modified D-rack circuits and passes only frequencies in the neighborhood of 425 cps and 500 cps. The outputs of both filter-amplifiers will be combined in a variable pad located within reach of the pilot.

l. A governor-controlled d-c motor driving microswitches through a gear train and cam will be used as a timer. Each timer will provide one switching period having a 50% duty cycle and will simultaneously switch the receivers for all bands to their corresponding right, or left antennas. In addition, the timer will key the 3-kc tone in each recorder to identify the direction in which the system is looking.

m. To change the switching period, the timer will be replaced as a plug-in unit. Four periods; 5 sec, 30 sec, 3 minutes and 15 minutes will be provided by the set of timers supplied with the systems. Eight timers having a 30-second period, eight having a 3-minute period, four having a 5-second period and four having a 15-minute period, will be provided for use with eight systems.

n. All the units of the system which are located in the equipment bay will be mounted on the hatch cover. Removal of the hatch cover will expose the units for service and will provide normal access to the camera equipment.

o. The cables which carry signals will be of the coaxial or shielded type. All cables of significant length will be driven by low impedance sources.

p. All units of the system which have not demonstrated satisfactory service in prior systems will be environmentally tested before being included in System 6. Extensive flight testing of the first system will be carried out so that any malfunctioning may be corrected before delivery.

q. A summary of the estimated performance of System 6 is shown on the following page. Following this tabulation, the installation of the units associated with each of the four bands is described and discussed in more detail.

Summary of Estimated Performance

Band	Beam Depression Below Horizon, Degrees	Frequency, MC	Antenna Beamwidth Average 2 Planes, Degrees	Receiver Sensitivity, dbm	Antenna Effective Area, * cm^2	Overall System Sensitivity, ** mw/cm^2
P	See Note	50	See Note	-81	2340	8.5×10^{-12}
		60		-84	3260	3.1×10^{-12}
		120		-87	1820	5.5×10^{-12}
		300		-87	410	24×10^{-12}
L	-45	300	81	-48	610	21×10^{-8}
	-45	550	74	-50	700	11×10^{-8}
	-45	1000	68	-50	315	25×10^{-8}
S	-12	1000	50	-47	658	24×10^{-8}
	-12	3000	19	-47	291	55×10^{-8}
	-12	8000	7	-47	146	109×10^{-8}
X	-12	8000	16	-62	82	3.9×10^{-8}
	-12	11000	12	-60	55	9.3×10^{-8}
	-12	14000	10	-37	31	3340×10^{-8}

* Defined as $\frac{\lambda^2}{4\pi}$ (Maximum Power Gain) and includes antenna efficiency and mismatch loss.

** This is tangential sensitivity at output of tape and includes antenna efficiency and RF mismatch losses, 2 db filter insertion losses and a 4 db degradation factor to account for recording losses and is calculated for a linearly polarized signal in direction of beam maximum for either vertically or horizontally polarized signals.

Note Use of the belly mounted scimitar is assumed. This antenna does not produce a single lobed radiation pattern. For the above calculations it has been assumed this antenna has a maximum gain of -5 db with respect to a $\lambda/2$ dipole.

2. X-Band Installation

The characteristics of the X-Band (8 kmc to 14 kmc) installation may be described as follows:

a. As indicated in figure 2, the main portion of the X-Band installation will be located in the equipment bay of the aircraft.

b. The S-603 dual channel traveling wave tube preamplifier will be used to amplify the signals from the six-inch diameter parabolic antennas.

c. Waveguide-to-coaxial-line transitions will be used to connect the waveguide fed X-Band antennas to the coaxial line inputs of the traveling wave tube amplifier.

d. It will be necessary to use the small size (RG/142U) cable in the r-f lines to prevent the appearance of the high order mode losses characteristic of larger size coaxial cables in the neighborhood of 9 kmc.

e. The right-left switch will be located in the video lines for this band.

f. Because of the small beamwidths of the X-Band antennas, these will be mounted so that their beam maxima lie at a depression angle of 12^{o}.

g. Signals from the information amplifier will be sent to the recorder located in the pilot's compartment.

h. The cutoff characteristics of the waveguide antenna feed and of the traveling wave tube amplifier will be employed to define the band edges. Therefore, no additional r-f filters will be used.

3. S-Band Installation

The characteristics of the S-Band (1 kmc to 8 kmc) installation may be described as follows:

a. The S-Band installation will be mounted in the customary "System 1" location in the nose of the vehicle.

b. Bow-tie antennas (17-inch diameter parabolic reflectors excited by broadband fan dipoles) will be mounted at a 12-degree depression angle to properly position their beams with respect to the horizon.

c. A filter set will be provided for each antenna so that the following frequency bands may be selected at will:

1 kmc to 2 kmc	1 kmc to 4 kmc
2 kmc to 4 kmc	2 kmc to 8 kmc
4 kmc to 8 kmc	1 kmc to 8 kmc

d. A broadband crystal detector will be used following each filter and the video outputs of the detectors will be switched into a single information amplifier.

e. The output signal of the information amplifier will be delivered to the recorder in the pilot's compartment.

f. Provision will be made for the future installation of a traveling wave tube amplifier in the nose of the aircraft. This amplifier will be similar to the model S-603 which will be used in the X-Band installation.

4. L-Band Installation

a. The L-Band installation (300 mc to 1000 mc) will be mounted in the equipment bay area and will be attached to the hatch cover, as in the case of the X-Band assembly.

b. The antennas for this band will be spiral antennas having a diameter of 15 inches. These will be mounted at a depression angle of 45 degrees to properly locate their beams (60 to 80 degrees).

c. The standard L-Band antennas must be modified so that they can be used with the "B" camera configuration. For this reason, it will be necessary to indent the back of the reflector, and to relocate the balun on the back of each antenna. The modification of the right-side antenna will be different from the modification of the left-side antenna. These modifications are not required for the antennas to be used with the "A" camera configuration but they are permissible. Thus, one right-side and one left-side B-type antenna will be supplied per system and will operate with either hatch cover.

d. The filter set which will be provided for the L-Band antennas permits the choice of the following operating bands:

300 mc to 600 mc
300 mc to 1000 mc
600 mc to 1000 mc

e. The switch for L-Band will be located in the r-f cables ahead of the filter and detector assembly. This position of the switch has been chosen with an eye towards the future installation of a single channel r-f amplifier to cover the 300mc-to-600mc band. If the amplifier is installed, a multi-coupler can be used to separate the 300mc-to-600mc band, and to supply the 600mc-to-1000mc band directly to a crystal

detector. The crystal detector can be fed into an early stage of the information amplifier and the output of the amplifier fed into a later stage. In this way, efficient signal mixing can be obtained when signals in the entire 300mc-to-1000mc band are desired.

f. The output signals of the information amplifier will be fed to the recorder located in the cheek area.

5. P-Band Installation

a. As indicated previously, the P-Band installation (50 mc to 300 mc) will include two alternate antenna configurations. Both configurations will provide sensitivity to horizontally and vertically polarized signals. The first configuration will comprise a pair of scimitar antennas, one mounted on each side of the vehicle, above and behind the wings and protruding radially from the fuselage at an angle of about 35 degrees above the horizontal. This pair of antennas will be connected to a right-left switch and then through a distributed amplifier to the remaining information amplifier. (See figure 1.)

b. (See figure 3.) The scimitar design will be approximately 40 inches high by 50 inches long. The antenna will be constructed of stainless steel and, to minimize drag, will not be provided with a dielectric insert, since by leaving it "open" a freer passage will be available for the back wash from the wings.

c. However, because the size and location of this installation may compromise the peak aerodynamic performance of the vehicle, an alternate antenna configuration, which will not degrade aircraft performance significantly, will be available for use on missions where vehicle performance cannot be compromised. This antenna will take the form of a single modified scimitar design mounted on the ventral surface of the vehicle, between the wheel doors and the fuselage break. (A sketch of the antenna is shown in figure 4.) When used, the switch will be bypassed and the antenna will be connected directly into the preamplifier. Thus, no right-left directional information will be available.

d. The antenna mounting for the pair and for the single antenna will be designed so that either configuration may be installed or removed quickly and easily as required by the nature of the mission.

e. At present, only rough estimates of the performance of the P-Band antennas can be given. The VSWR behaviour shown in figures 3 and 4, is seen to be adequate. Antenna efficiencies are expected to be high since they are reasonably large electrically and are constructed of low loss materials. However, in the P-Band frequency range, the patterns of an antenna mounted on an airframe of the size of the vehicle to be used are markedly influenced by the structure of that airframe. The pattern studies which have been made of the scimitar designs proposed made use of an extremely crude model of the airframe. Hence, only in a very gross sense can the patterns obtained be relied upon to conform to those which will be obtained in practice. With the above in mind, the following pattern behaviour may be expected:

(1) For vertically polarized signals, a right-, or left-side mounted scimitar will exhibit a broad lobe directed to the corresponding side and downwards. In addition, a corresponding lobe, directed upward and therefore useless, will be exhibited on the other side of the vehicle.

(2) For horizontally polarized signals, a side mounted scimitar will have a lobe directed towards the horizon and backwards by some 10 degrees from the broadside. In general, the lobe will be broader in the elevation plane than in the azimuthal plane. The sensitivity to signals coming from the side opposite to that on which the antenna is mounted will be insignificant.

(3) No directional information will be available from the belly mounted scimitar. For both polarizations, lobes will be produced which will be directed off to both sides and downwards. The patterns will, in general, be multi-lobed

and narrower for horizontally polarized signals than for vertically polarized signals.

(4) The P-Band preamplifier will provide 40-db gain and will have a tap point at the 15-db gain level to supply signals to the "System 3" which may be optionally carried in the cheek area of the aircraft.

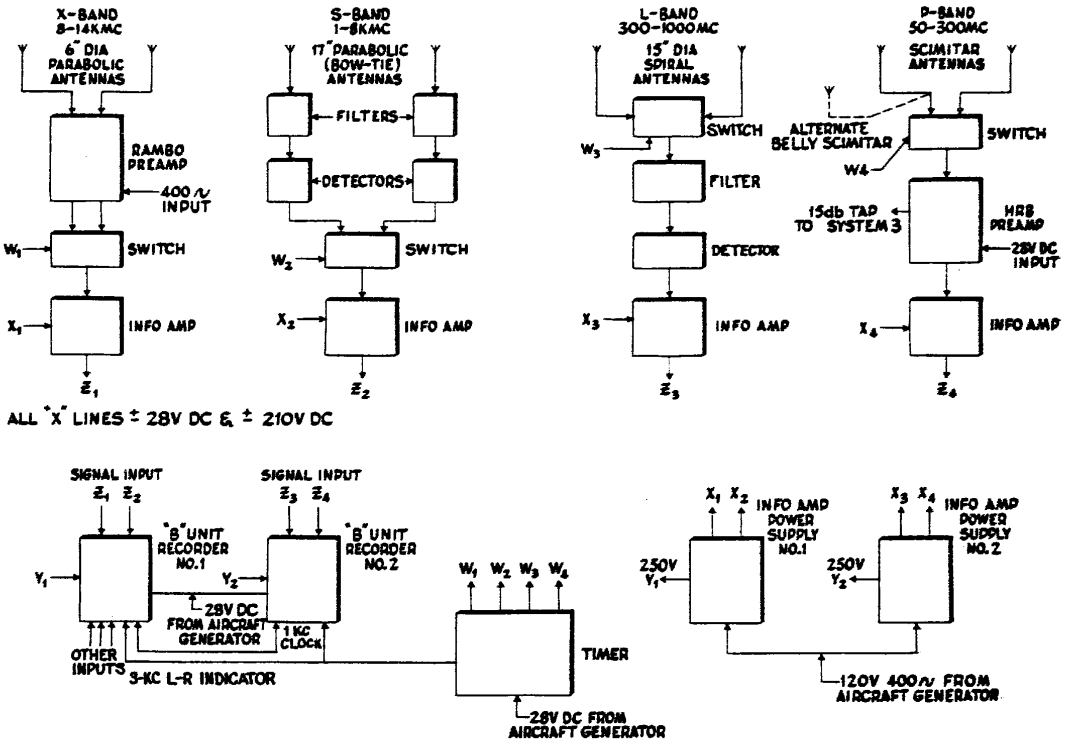

FIGURE 1 "INTERIM" MODEL SYSTEM 6 BLOCK DIAGRAM

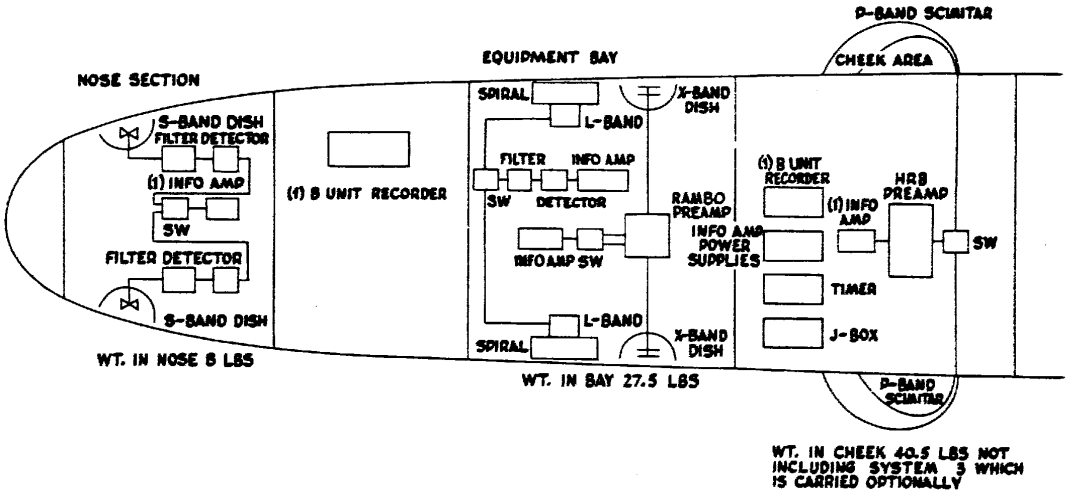

FIGURE 2 SYSTEM 6 COMPONENTS LOCATION

NOTE

ADD 20 LBS FOR BRACKETS AND CABLING.

P-BAND ANTENNA WILL CONSIST OF 3 REMOVABLE SCIMITARS, ONE BELLY MOUNTED USED ALONE, OR TWO SIDE MOUNTED USED TOGETHER.

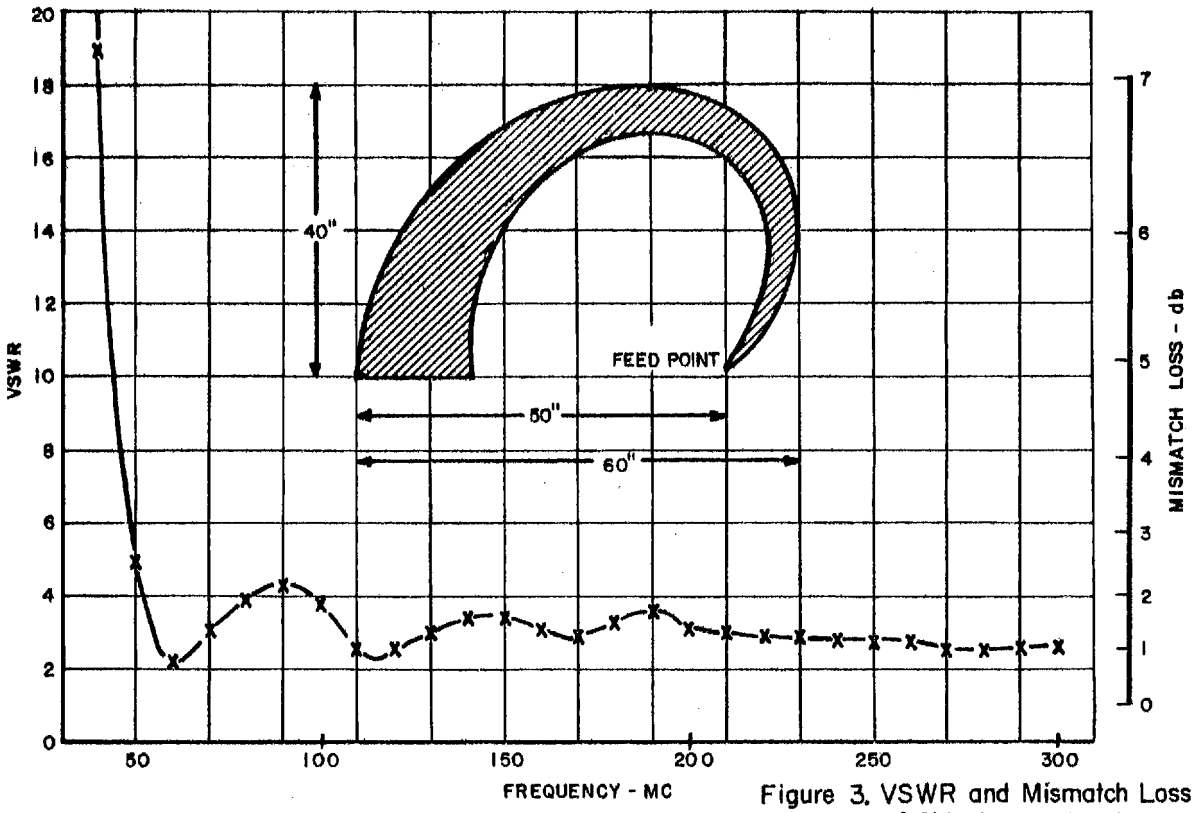

Figure 3. VSWR and Mismatch Loss of Side-Mounted Scimitar

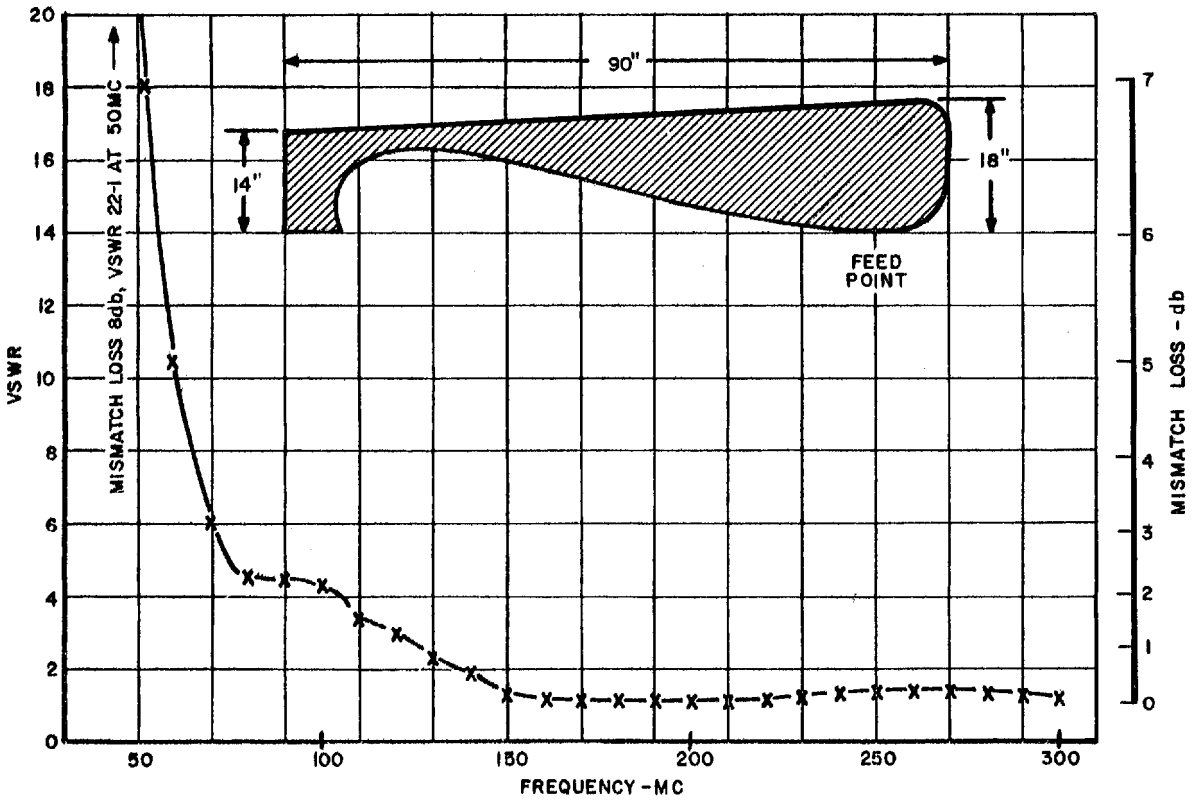

Figure 4. VSWR and Mismatch Loss of Belly-Mounted Scimitar